



February 23, 2004

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Via Federal Express

John Aguada
1746 Mirabella Court
Milpitas, CA 95035

Re: U.S. Patent Application Entitled,
"METHOD FOR DIE REMOVAL FROM PLASTIC PACKAGES"
Filing Date: Not Yet Filed
Altera File No. A1190

Dear John:

We are currently ready to file this patent application in which you are one of the inventors. Enclosed herein please find the following documents regarding the above named patent application:

Declaration;
Assignment; and
A copy of the patent application in final form to be filed with the Patent Office

Please sign and date the Declaration and Assignment where indicated and return these two documents and the patent application as soon as possible. A return federal express envelope has been enclosed for your convenience.

Please contact Kim Clinger if you have any questions at (408) 544-8675.

Thank you for your cooperation.

Sincerely,

A handwritten signature in black ink, appearing to read "Michelle Romero".

Michelle Romero
Patent Administrator

Enclosures

From: MICHELLE A ROMERO (408)544-8357
ALTERA CORPORATION
101 INNOVATION DRIVE
MAIL STOP 1405
SAN JOSE, CA, 95134

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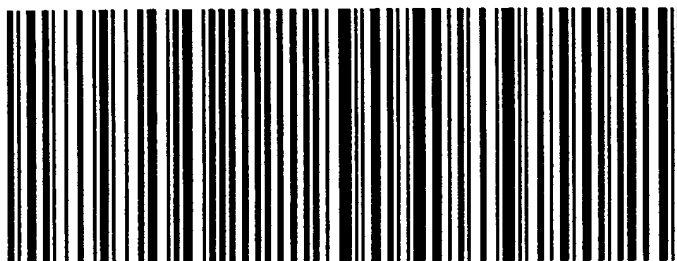
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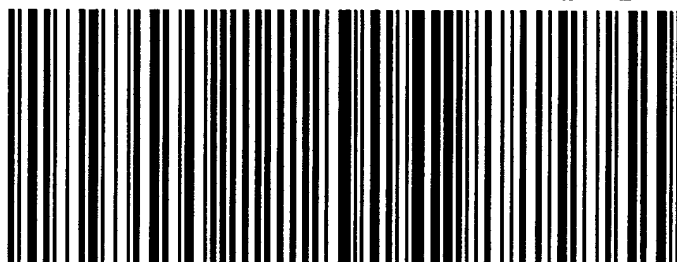
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ASSIGNMENT

WHEREAS, WE, VIJAY CHOWDHURY, a citizen of the United States, residing at 1639 Vinehill Court, Fremont, California 94539; and JOHN AGUADA, a citizen of the United States, residing at 1746 Mirabella Court, Milpitas, California 95035 ASSIGNORS, are the inventors of the invention in *A Novel Method for Die Removal from Plastic Packages* for which we have executed an application for a Patent of the United States

- ☐ which is executed on ☐ even date herewith or ☐
☒ which is identified by Pennie & Edmonds LLP docket no. 9818-102-999
☐ which was filed on , Application No.
☐ We hereby authorize and request our attorney, , of Pennie & Edmonds, LLP, , to insert here in parentheses (Application number, _____ filed _____) the filing date and application number of said application when known.

and WHEREAS, ALTERA CORPORATION, ASSIGNEE is desirous of obtaining our entire right, title and interest in, to and under the said invention and the said application:

NOW, THEREFORE, in consideration of the sum of One Dollar (\$1.00) to us in hand paid, and other good and valuable consideration, the receipt of which is hereby acknowledged, we, the said ASSIGNORS, have sold, assigned, transferred and set over, and by these presents do hereby sell, assign, transfer and set over, unto the said ASSIGNEE, its successors, legal representatives and assigns, our entire right, title and interest in, to and under the said invention, and the said United States application and all divisions, renewals and continuations thereof, and all Patents of the United States which may be granted thereon and all reissues and extensions thereof; and all applications for industrial property protection, including, without limitation, all applications for patents, utility models, and designs which may hereafter be filed for said invention in any country or countries foreign to the United States, together with the right to file such applications and the right to claim for the same the priority rights derived from said United States application under the Patent Laws of the United States, the International Convention for the Protection of Industrial Property, or any other international agreement or the domestic laws of the country in which any such application is filed, as may be applicable; and all forms of industrial property protection, including, without limitation, patents, utility models, inventors' certificates and designs which may be granted for said invention in any country or countries foreign to the United States and all extensions, renewals and reissues thereof;

AND WE HEREBY authorize and request the Commissioner of Patents and Trademarks of the United States, and any Official of any country or countries foreign to the United States, whose duty it is to issue patents or other evidence or forms of industrial property protection on applications as aforesaid, to issue the same to the said ASSIGNEE, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

AND WE HEREBY covenant and agree that we have full right to convey the entire interest herein assigned, and that we have not executed, and will not execute, any agreement in conflict herewith.

AND WE HEREBY further covenant and agree that we will communicate to the said ASSIGNEE, its successors, legal representatives and assigns, any facts known to us respecting said invention, and testify in any legal proceeding, sign all lawful papers, execute all divisional, continuing, reissue and foreign applications, make all rightful oaths, and generally do everything possible to aid the said ASSIGNEE, its successors, legal representatives and assigns, to obtain and enforce proper protection for said invention in all countries.

IN TESTIMONY WHEREOF, We hereunto set our hands and seals the day and year set opposite our respective signatures.

Date 11/6/04, 2003

Vijay Chowdhury L.S.

Date _____, 2003

John Aguada L.S.

DECLARATION FOR NON-PROVISIONAL PATENT APPLICATION*

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below at 201 et seq. beneath my name.

I believe I am the original, first and sole inventor if only one name is listed at 201 below, or an original, first and joint inventor if plural names are listed at 201 et seq. below, of the subject matter which is claimed and for which a patent is sought on the invention entitled

A Novel Method for Die Removal from Plastic Packages

and for which a patent application:

- ☐ is attached hereto and includes amendment(s) filed on (if applicable)
- ☐ was filed in the United States on as Application No. (for declaration not accompanying application) with amendment(s) filed on (if applicable)
- ☐ was filed as PCT international Application No. on and was amended under PCT Article 19 on (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified application, including the claims, as amended by any amendment referred to above

I acknowledge the duty to disclose information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

EARLIEST FOREIGN APPLICATION(S), IF ANY, FILED PRIOR TO THE FILING DATE OF THE APPLICATION				
APPLICATION NUMBER	COUNTRY	DATE OF FILING (day, month, year)	PRIORITY CLAIMED	
			YES <input type="checkbox"/>	NO <input type="checkbox"/>
			YES <input type="checkbox"/>	NO <input type="checkbox"/>

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

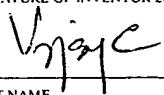
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I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information known to me which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

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*
for use only when the application is assigned to a company, partnership or other organization.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

2 0 1	FULL NAME OF INVENTOR	LAST NAME Chowdhury	FIRST NAME Vijay	MIDDLE NAME	
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	SIGNATURE OF INVENTOR 201 			DATE 1/6/04	
2 0 2	FULL NAME OF INVENTOR	LAST NAME Aguada	FIRST NAME John	MIDDLE NAME	
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	POST OFFICE ADDRESS	STREET	CITY	STATE OR COUNTRY	ZIP CODE
	SIGNATURE OF INVENTOR 203			DATE	
2 0 4	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME	
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	SIGNATURE OF INVENTOR 204			DATE	
2 0 5	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME	
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	SIGNATURE OF INVENTOR 205			DATE	

A Novel Method for Die Removal from Plastic Packages

FIELD OF THE INVENTION

[0001] The present invention relates generally to the field of integrated circuit manufacturing and, in particular, to a novel method for removing a die from a plastic package.

BACKGROUND OF THE INVENTION

[0002] Semiconductor device manufacturing principally involves two complex processes, die fabrication and device packaging. Problems associated with any of the two processes may cause the integrated circuit (IC) on the die to malfunction. Failure analysis is an important step in IC production for the purpose of identifying defects in a fabricated die, deducing causes for such defects and coming up with corresponding solutions. As a precondition of failure analysis, a die needs to be removed intact from the package that encases the die before taking any further analytical steps, e.g., parallel lapping and cross-sectioning.

[0003] Conventionally, a die is removed from its plastic package through a chemical approach. For example, a die and its plastic package may be submerged in a solvent comprising 50% nitric acid and 50% water. The package material, e.g., a phenol-based compound, reacts with the nitric acid and is then completely dissolved in the solvent. However, since those materials that constitute the die do not react with the solvent, the die itself remains intact. The die is then removed from the solvent and rinsed several times with water to clear away any residual solvent and/or package material from its surface.

[0004] There are several issues with this conventional approach. First, the nitric acid solvent is hazardous and an operator needs to be extremely careful and wear protective clothing and gloves during the die removal operation. Second, this approach is time consuming. It takes at least an hour for the package to be completely dissolved and the die to be rinsed and dried.

[0005] In view of the aforementioned problems, it would be desirable to develop a die removal method that is both safer and more efficient.

SUMMARY

[0006] The present invention is directed to a novel method for removing a die from a plastic package. Unlike the conventional approach, this method does not involve any chemical reaction and it is purely a mechanical procedure, which is safer and more efficient.

[0007] The first step of the invention is to remove the cap of a plastic package and expose the die embedded inside the package. The second step is to place the remaining package on a hot plate and then increase the temperature of the hot plate. When the temperature of the plastic package reaches about 460°C, the package cracks, resulting in at least one fracture in the package. Such high temperature also melts down the solder connections connecting the die and the package as well as the epoxy between the die and package. The last step is to grasp the cracked plastic package on either side of the fracture and tear it apart. As a result, the die will be released from the remaining package.

[0008] The invention does not involve any chemical reaction as discussed above in connection with the conventional approach. It is both safe and efficient. The whole process takes less than 15 minutes. Further, the die released from the plastic package according to the invention can be used directly in failure analysis without any further cleaning procedures required by the conventional approach.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The aforementioned features and advantages of the invention as well as additional features and advantages thereof will be more clearly understood hereinafter as a result of a detailed description of preferred embodiments of the invention when taken in conjunction with the drawings wherein:

[0010] Fig. 1 is a plan view of a thin quad flat pack (TQFP) package;

[0011] Fig. 2 is a plan view of a de-capped TQFP package;

[0012] Fig. 3 illustrates the step of heating the de-capped package using a hot plate until it cracks;

[0013] Fig. 4 illustrates the step of grasping the cracked package with two pairs of flat-face pliers to break the cracked package into multiple pieces;

[0014] Fig. 5 illustrates the step of twisting the two pairs of pliers in opposite directions to break the cracked package; and

[0015] Fig. 6 shows the broken package and a die released from the package.

[0016] Like reference numerals refer to corresponding parts throughout the several views of the drawings.

DESCRIPTION OF EMBODIMENTS

[0017] The present invention relates to a die removal method that is safer and more efficient than the conventional chemical reaction approach. The die released from a plastic package according to the invention can be used directly in failure analysis.

[0018] Fig. 1 is a plan view of an illustrative thin quad flat pack (TQFP) package 100. The TQFP package 100 includes a plurality of pin leads 110 deployed on its four edges and a cap 120 on its top to cover a die embedded in the package (not shown).

[0019] Fig. 2 is another plan view of the TQFP package 100 after its cap is removed. At the center of the de-capped package 100 is a die 130. The texture on the surface of die 130 suggests that an integrated circuit is fabricated thereon. Surrounding the die 130 are a plurality of bond wires 140 that serve as part of the signal paths between the circuit on this die and the pin leads 110. One end of each bond wire is soldered to a bond pad on the die surface and the other end of the bond wire is soldered to a bond pad on the package 100. The melting temperature of the soldering material is about 240°C. To reduce stress concentration at any solder joint between the die 130 and the package 100 and avoid possible electrical short circuits between adjacent bond wires, an encapsulant (not visible in Fig. 2), e.g., epoxy, is introduced into the package to fill the space between the die and the package and the space between adjacent bond wires. The melting temperature of the epoxy is approximately 150°C.

[0020] After removing its cap, the package 100 is placed on top of a hot plate 300 as shown in Fig. 3. The temperature of the hot plate is controlled by an electrical heater 310. In one embodiment, the heater is turned on and set to produce a temperature of 460°C. As a result, the temperature of the package on the hot plate increases and the package 100 also expands accordingly. Such expansion may cause thermal stress concentration at certain parts of the package due to non-uniformity of the heating process. When the thermal stress reaches a certain limit that is mainly dependent upon the elastic modulus of the package material, the plastic package cracks and produces one or more fractures in the package. Meanwhile, the solder joints and the epoxy between the die and the package can not sustain such high temperature either. They slowly melt down as the package's temperature increases. Therefore, the die is no longer firmly attached to the package. However, the die itself remains intact during the heating process because the materials that constitute the die and the circuit can endure a temperature as high as 800°C.

[0021] After the package cracks, it is removed from the hot plate. Before the temperature drops significantly, a fracture 150 that preferably splits the package into two halves is quickly identified. As shown in Fig. 4, two pairs of pliers 400 and 410, one pair on each side of the fracture 150, are used to grasp the package and pull it apart. In some cases, such as that shown in Fig. 4, there may be additional fractures such as fractures 170 on the right side of the die. In such cases, the two pairs of pliers are also used to grasp the two sides of the package along the fracture 170 to further detach the die 130 from the cracked package 100. The areas on the package that are grasped by the two pairs of pliers should be about 1 mm away from the edges of the die to avoid having the pliers damage the die when the die is released from the cracked package.

[0022] There are different techniques for pulling apart the cracked plastic package. In one embodiment (see Fig. 5), one pair of pliers 400 is twisted in a clockwise direction and the other pair of pliers 410 in a counter-clockwise direction. In another embodiment, the two pairs of pliers are pulled away from each other in two opposing directions in the same plane. In yet another embodiment, the two pairs of pliers are pulled away from each other in the two opposing directions in different planes that are parallel to each other. The choice of die removal technique, to a certain degree, depends upon the shape and orientation of the fractures in the plastic package.

[0023] Finally, Fig. 6 shows the broken package 100 and the die 130 released from the package. This whole process takes less than 15 minutes, compared with the conventional approach that takes at least a hour. Further, this package has avoided the chemical reaction of the conventional approach and therefore there is no need for die cleaning. The die 130 can be used for failure analysis without further processing.

[0024] The foregoing description, for purpose of explanation, has been set forth with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated.

What is claimed is:

1. A method for removing a die from a plastic package, comprising:
removing a package cap from a top surface of the plastic package;
heating the plastic package enough such that the plastic package cracks, the cracking resulting in at least one fracture in the plastic package; and
grasping the plastic package on either side of the fracture and opening the package to detach the die from the cracked plastic package.
2. The method of claim 1, wherein the plastic package is held by two pairs of pliers, one pair of pliers on either side of the fracture.
3. The method of claim 2, wherein the two pairs of pliers are pulled in two opposite directions that are in substantially a same plane.
4. The method of claim 2, wherein the two pairs of pliers are pulled in two opposite directions in two planes that are parallel to each other.
5. The method of claim 2, wherein one of the two pairs of pliers is twisted in a clockwise direction and the other of the two pairs of pliers is twisted in a counter-clockwise direction.
6. The method of claim 2, wherein each pair of pliers grasps one area of the plastic package on one side of the fracture and the two areas that are grasped by the two pairs of pliers are substantially away from the die.
7. The method of claim 6, wherein each of the two pairs of pliers has a pair of flat surfaces and each pair of pliers grasps one of the two areas using its pair of flat surfaces.
8. The method of claim 1, wherein the die is attached to the plastic package through an array of solder connections and epoxy material.
9. The method of claim 8, wherein the plastic package is heated sufficiently high to melt down the solder connections and the epoxy material without damaging the die.
10. The method of claim 1, wherein the step of heating the plastic package comprises placing the plastic package on a hot plate.
11. The method of claim 10, wherein the temperature of the hot plate is about 460°C.

A Novel Method for Die Removal from Plastic Packages

ABSTRACT OF THE INVENTION

A method for removing a die from a plastic package. The first step of the method is to remove the package's cap. Next, the package and the die within it are placed on a hot plate and heated up. When the plastic package's temperature reaches a certain limit, the plastic package cracks, resulting in at least one fracture in the package. Each side of the cracked plastic package along the fracture is then grasped by a pair of pliers and the two pairs of pliers are pulled in opposite directions. As a result, the die is detached from the plastic package.

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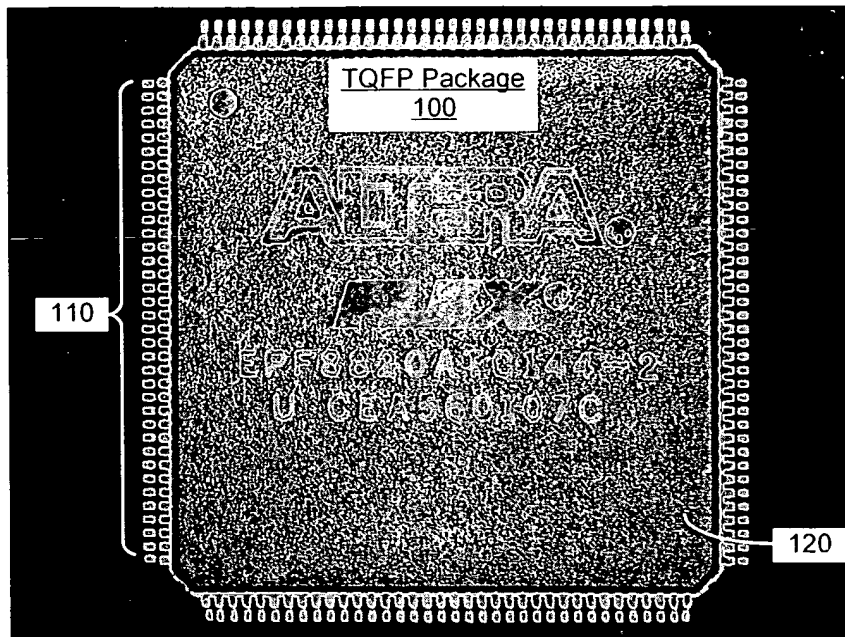


FIG. 1

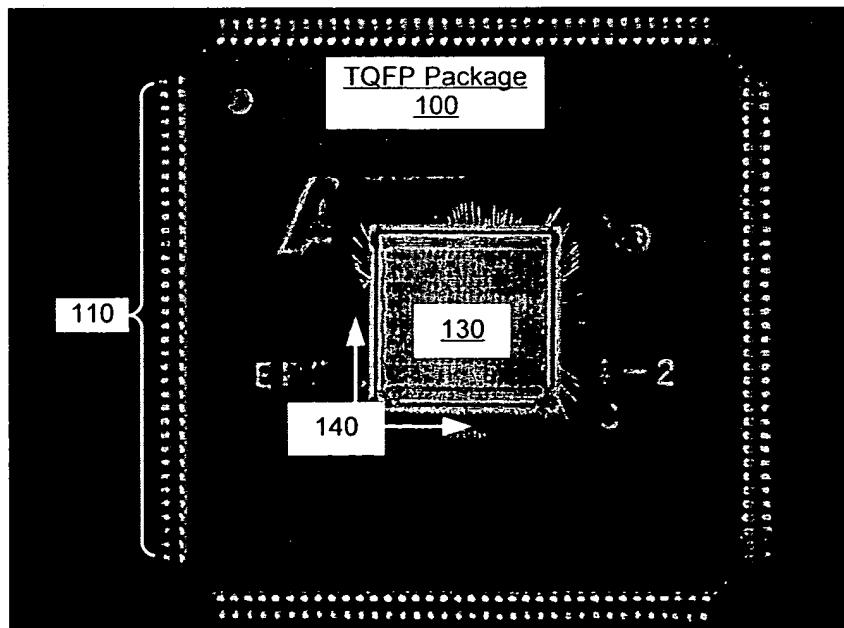


FIG. 2

This micrograph shows a TQFP package (100) mounted on a substrate. The package is square with a central square opening (130). A die paddle is visible within the package. Arrows point to various features: Package Fractures 150 (along the edges of the package), Die Paddle (the central square opening), TQFP Package 100 (the package itself), Fracture 170 (a crack on the right side), 130 (the central opening), 400 (a feature at the bottom left), and 410 (a feature at the bottom right).

FIG. 4

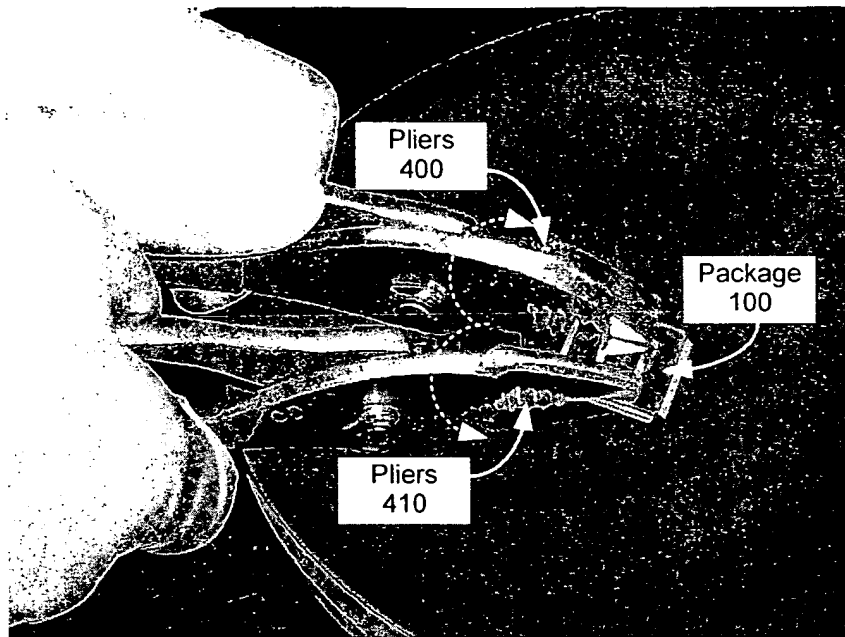


FIG. 5

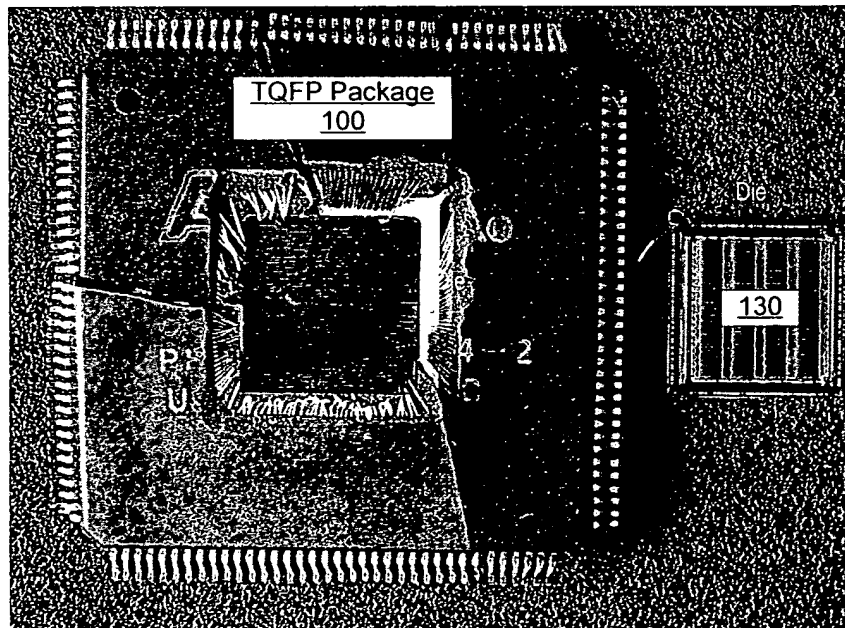


FIG. 6